

# Risk factors of asthma among the Saudi pediatric population between 1 and 15 years old

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**ABSTRACT**

**Background:** Asthma is a widespread medical problem among the pediatric age group in Saudi Arabia. This study describes asthma risk factors relevant to the Saudi population. The main objective of this study is to determine the risk factors for developing asthma among Saudi children. **Methods:** A descriptive cross-sectional study was conducted in Saudi Arabia from June 2020 to October 2021, involving families with children from one to 15 years of age using an online survey. The questionnaire assessed the sociodemographic data of the families and the major asthma risk factors. Then, the data were analyzed using IBM SPSS. **Results:** A total of 996 family participated in the study, 766 families had asthmatic children 62.7% of them were males, with a mean age of  $10.6 \pm 4.9$  years old. From the asthmatic group 21.4% had rural residences compared to 7.4% from the healthy group ( $P=0.001$ ). Asthma was more prevalent in those with low income, having parents without university-education, having a family history of allergy or allergic rhinitis, and having a smoker in their families ( $P=0.001$ ). In the asthmatic group, a gas oven was used more than in the comparison group, house floors were covered in 29.8% compared to the other group and Insecticides were more commonly used in the asthmatic group ( $P=0.039$ ). **Conclusion:** Family history of asthma, allergies, and allergic rhinitis were the most significant familial risk factors. Presence of a family smoker, using a gas oven, house floor coverings and the frequent use of incense were more associated with asthma.

**Keyword:** Asthma, Risk factors, Saudi pediatric, Family history.

**1. INTRODUCTION**

Asthma is considered the most common chronic disease in the pediatric age group, and it is more implicated in school absenteeism than any other single chronic childhood condition (Alshehri et al., 2000). Although no nationwide prevalence studies have been published, asthma prevalence in Saudi children ranges from 8% to 25% according to studies conducted over the past three

decades, and the prevalence showed a variation among different regions of the country (Alahmadi et al., 2019). Various triggers can result in acute asthma attacks, and these triggers can be classified as indoor, outdoor, and occupational sensitizers. These include the following. Indoor allergens and air pollutants, such as dust mites, cockroaches, animals (especially cats), and fungi (Al-Moamary et al., 2019). Outdoor allergens, such as pollens and molds, cannot be avoided completely; however, one can reduce the exposure by insulating their houses from the outer environment and using air conditioning. Cold weather, low humidity, and polluted air are also considered risk factors. Dust storms do not usually precipitate asthma attacks, although mild symptoms could be aggravated, and this effect can be even worse in uncontrolled asthmatics (Alangari et al., 2015).

Once an occupational sensitizer is identified, it is advisable that the affected person avoids that environment. The sooner this irritant is removed, the more likely you are to make a full recovery from occupational asthma. Foods and dietary supplements rarely cause asthma. However, certain drugs that could aggravate asthma symptoms should be avoided (e.g., beta-blockers) whenever possible (Al-Moamary et al., 2019). The literature shows many studies performed in different parts of Saudi Arabia, most of which investigated different aspects of risk factors that we will discuss briefly. Starting with studies investigating environmental and indoor triggers, a study in the Najran region demonstrated multiple environmental factors associated with diagnosed severe asthma, such as using wood or coal to cook, living near dense truck traffic, having pet dogs, and having a smoker as a family member. Other triggers were recognized: these allergens include Cladosporium molds, pigweed, and Bermuda grass pollen (Alqahtani et al., 2017).

Another study was carried out by Hail, Al-Khobar, Jeddah, Qassim, Taif, Dammam, and Jizan, who investigating *A. viridis* pollen (which is known to be high allergenic) presence, and the levels in the environment exhibited a seasonal pattern that showed higher concentrations during August to November and peaking in October. Interestingly, during this period, *A.viridis* pollen showed a pattern of mid-day to early evening diurnal variation (Hasnain et al., 2007). A case control study that was conducted in Bahrah that assessed 220 samples showed that brick factories, family, and self-history of rhinitis, skin atopic dermatitis, or persistent lung infections were risk factors for bronchial asthma (Al-Mazam & Mohamed, 2001). A matched case-control study in 2014 of more than 1,200 school children aged 6 to 8 years old with and without asthma in Madinah, Saudi Arabia confirmed the presence of an association between high BMI and asthma in both genders of pre-pubertal Saudi children (Nahhas et al., 2014). Other aspects involving food as a risk factor have been explored by multiple studies. For instance, a study in 2000 investigated more than 1300 asthmatic patients for clinical sensitivity to food and the relationship to respiratory symptoms. From their cross-sectional (using questionnaires) and longitudinal study (involving diet diaries) during patient visits to the asthma clinic, the study reported a prevalence of clinical sensitivity to food of 29% (Aba-Alkhail & El-Gamal, 2000). Another study suggested that fast food, vegetable, and egg consumption was linked to asthma. On the contrary, seafood, dairy products, and fruit were found to have a protective effect in Saudi children. Serum vitamin D levels in children and adults with asthma were found to be lower than their non-asthmatic counterparts in Saudi Arabia and Qatar (Alsharairi, 2019).

In 2016, a study was conducted in Najran that asthma and other allergy diseases had a variety of risk factors to consider. It showed that male gender, consumption of hamburger stand, A truck passes in front of the house, and having a pet dog or cat are all considered significant risk factors for asthma (Alqahtani, 2016). Asthma control status among children in Saudi Arabia is unfortunately low, which explain the low quality of life (Banjari et al., 2018; R & R, 2016). Thus, identifying a generalized set of risk factors and tackling them is relevant to the literature and applicable to the Saudi population. In most prior studies have used multiple different methods and have assessed different aspects in different locations, this study will provide valuable information about the risk factors that are relevant to the Saudi population as a whole, offering better practice and better knowledge for both patients' families and physicians. Our objective was to determine the risk factors for developing asthma among Saudi children.

## 2. METHODS

A descriptive cross-sectional study was performed with the participation of 996 children in the Saudi Arabia from June 2020 to October 2021. The sample was reached using an online survey distributed to parents, and only those who have children aged one to 15 years were allowed to participate. In total, 996 forms that were properly filled out were considered for our study. A questionnaire based on a previous study performed in Saudi Arabia (Aba-Alkhail & El-Gamal, 2000; Al-Mazam & Mohamed, 2001; Al Ghamdi et al., 2019; Alqahtani, 2016; Alqahtani et al., 2017; Alruwaili & Elwan, 2018; Alshehri et al., 2000; Hamam et al., 2015; Moradi-Lakeh et al., 2015) was set up, and some modifications were made to meet the requirements of this study. The questionnaire was developed in English and then translated in Arabic as an online survey due to COVID-19 circumstances and schools being shut down.

The questionnaire consisted of two main parts. The first part of the questionnaire focused on the sociodemographic data of the family. The second part focused on the major risk factors, which included exposure to tobacco smoke at home, incense, whether the house floors were covered or not, presence of any pets, family history of asthma, family history of allergies, and type of cooking fuel used at home, air conditioning, and birth order. After the data were extracted, they were revised, coded, and entered into statistical software IBM SPSS version 22(SPSS, Inc. Chicago, IL). The statistical analysis was done using two tailed tests. A P value less than 0.05 were statistically significant. A frequency distribution for asthmatic children's personal data and asthma related factors was conducted.

A comparative analysis between study groups based on frequency and percent distribution was performed for all variables, including demographic data, family-related risk factors, and environmental risk factors, and tabulated. Relations were tested using the Pearson chi-square test. A multiple logistic regression model was used to estimate the most significant adjusted risk factors of asthma among the children based on a backwards LR model. After ethical clearance, consent was obtained from the parents of the children before allowing them to start answering the questionnaire. Privacy and confidentiality of all participants were maintained.

### 3. RESULTS

The study participants included 996 family respondents, of whom 766 had asthmatic children and 230 had healthy children (free of asthma). Exactly 21.4% of those in the asthmatic group lived in rural residences compared to 7.4% of the healthy group with statistical significance ( $P=0.001$ ). Regarding monthly income, 18.5% of the asthmatic group had monthly income exceeding 20,000 SR compared to 33.9% in the comparison group ( $P=0.001$ ). Exactly 32.5% of families with an asthmatic child were in homes compared to 23% of those in the other group ( $P=0.002$ ). Regarding parental education, 57.5% of the asthmatic group had university-educated mothers compared to 75.2% of those in the comparison group ( $P=0.001$ ). Additionally, 53.9% of the asthmatic group had university-graduated fathers compared to 66.1% of those in the comparison group ( $P=0.001$ ). Considering the number of children aged 15 years or less, exactly 19.1% of the asthmatic group had 5 children or more compared to 24.8% of those in the comparison group ( $P=0.014$ ) (Table 1).

**Table 1** Demographic data of children and their families for the study groups

| Demographic data          | Group     |         |     |       | p-value |
|---------------------------|-----------|---------|-----|-------|---------|
|                           | Asthmatic | Healthy | No  | %     |         |
| <b>Residence</b>          |           |         |     |       |         |
| <i>Rural</i>              | 164       | 21.4%   | 17  | 7.4%  | .001*   |
| <i>Urban</i>              | 602       | 78.6%   | 213 | 92.6% |         |
| <b>Monthly income</b>     |           |         |     |       |         |
| < 10000 SR                | 252       | 32.9%   | 64  | 27.8% | .001*   |
| 10000–20000 SR            | 372       | 48.6%   | 88  | 38.3% |         |
| > 20000 SR                | 142       | 18.5%   | 78  | 33.9% |         |
| <b>Residence setting</b>  |           |         |     |       |         |
| <i>Home</i>               | 249       | 32.5%   | 53  | 23.0% | .002*   |
| <i>Flat</i>               | 234       | 30.5%   | 97  | 42.2% |         |
| <i>Villa</i>              | 283       | 36.9%   | 80  | 34.8% |         |
| <b>Mother's education</b> |           |         |     |       |         |
| <i>Illiterate</i>         | 59        | 7.7%    | 16  | 7.0%  |         |
| <i>Basic</i>              | 112       | 14.6%   | 18  | 7.8%  | .001*   |
| <i>Secondary</i>          | 157       | 20.5%   | 23  | 10.0% |         |
| <i>University / above</i> | 438       | 57.2%   | 173 | 75.2% |         |
| <b>Father's education</b> |           |         |     |       |         |
| <i>Illiterate</i>         | 13        | 1.7%    | 3   | 1.3%  |         |
| <i>Basic</i>              | 116       | 15.1%   | 13  | 5.7%  | .001*   |
| <i>Secondary</i>          | 224       | 29.2%   | 62  | 27.0% |         |
| <i>University / above</i> | 413       | 53.9%   | 152 | 66.1% |         |

| No. of children 15 years or less |     |       |     |       |       |
|----------------------------------|-----|-------|-----|-------|-------|
| 1–2                              | 305 | 39.8% | 102 | 44.3% | .014* |
| 3–4                              | 315 | 41.1% | 71  | 30.9% |       |
| 5+                               | 146 | 19.1% | 57  | 24.8% |       |

P: Pearson X<sup>2</sup> test

\*P < 0.05 (significant)

Table 2 shows the family-related risk factors of asthma among the study groups. Exactly 30.5% of the asthmatic group had families free of asthma history compared to 67.8% of those in the healthy group (P=0.001). Additionally, 23.9% of the asthma group had families free of allergy history compared to 51.7% of those in the comparison group (P=0.001), and 29.5% of the asthma group had families free of allergic rhinitis compared to 54.8% of those in the comparison group (P=0.001). Exactly, 38.4% of families with asthma children had a smoker in their family compared to 29.5% of those in the comparison group (P=0.001). The number of cigarettes and duration of smoking were insignificantly different among the groups.

**Table 2** Family-related risk factors for asthma among the study groups

| Family risk factors                        | Group     |       |         |       | p-value |
|--|-----------|-------|---------|-------|---------|
|  | Asthmatic |       | Healthy |       |         |
|  | No        | %     | No      | %     |         |
| <b>Family history of asthma</b>            |           |       |         |       |         |
| <i>Parents</i>                             | 196       | 25.6% | 37      | 16.1% | .001*   |
| <i>Siblings</i>                            | 346       | 45.2% | 39      | 17.0% |         |
| <i>None of them</i>                        | 234       | 30.5% | 156     | 67.8% |         |
| <b>Family history of allergy</b>           |           |       |         |       |         |
| <i>Parents</i>                             | 374       | 48.8% | 73      | 31.7% | .001*   |
| <i>Siblings</i>                            | 368       | 48.0% | 63      | 27.4% |         |
| <i>None of them</i>                        | 183       | 23.9% | 119     | 51.7% |         |
| <b>Family history of allergic rhinitis</b> |           |       |         |       |         |
| <i>Parents</i>                             | 362       | 47.3% | 75      | 32.6% | .001*   |
| <i>Siblings</i>                            | 275       | 35.9% | 48      | 20.9% |         |
| <i>None of them</i>                        | 226       | 29.5% | 126     | 54.8% |         |
| <b>Parental smoking</b>                    |           |       |         |       |         |
| <i>Both are smokers</i>                    | 16        | 2.1%  | 15      | 6.5%  | .001*   |
| <i>One of them</i>                         | 278       | 36.3% | 53      | 23.0% |         |
| <i>None of them</i>                        | 472       | 61.6% | 162     | 70.4% |         |
| <b>Number of cigarettes per day</b>        |           |       |         |       |         |
| < 10                                       | 166       | 56.5% | 41      | 60.3% | .843    |
| 10–20                                      | 96        | 32.7% | 20      | 29.4% |         |
| > 20                                       | 32        | 10.9% | 7       | 10.3% |         |
| <b>Years of smoking</b>                    |           |       |         |       |         |
| < 5  | 47        | 16.0% | 5       | 7.2%  | .175    |
| 5–10                                       | 59        | 20.1% | 15      | 21.7% |         |
| > 10                                       | 188       | 63.9% | 49      | 71.0% |         |

P: Pearson X<sup>2</sup> test

\*P < 0.05 (significant)

Table 3 shows the environmentally related risk factors for asthma among the study groups. Exactly 88.8% of the asthmatic group families use incense at home compared to 92.6% of those in the comparison group with no statistical significance (P=0.094). Asthma group frequency of using incense at home was higher than once per week, which was significantly higher than among the

other group (61.6% vs. 54%, respectively;  $P=0.029$ ). In addition, a gas oven was used for cooking in 40.4% of asthma group families compared to in 30% of families in the comparison group ( $P=0.001$ ). House floors were covered in 29.8% of those in the asthma group compared to 16.5% of those in the healthy group ( $P=0.001$ ). Using insecticides was reported among 48.6% of the asthma group compared to 40.9% of those in the comparison group ( $P=0.039$ ).

**Table 3** Environmentally related risk factors for asthma among the study groups

| Environmental risk factors          | Group                    |     |         |     | p-value |
|-------------------------------------|--------------------------|-----|---------|-----|---------|
|                                     | Asthmatic                |     | Healthy |     |         |
|                                     | No                       | %   | No      | %   |         |
| Have domestic animals               | Yes                      | 221 | 28.9%   | 58  | 25.2%   |
|                                     | No                       | 544 | 71.1%   | 172 | 74.8%   |
| Do parents use incense at home?     | Yes                      | 680 | 88.8%   | 213 | 92.6%   |
|                                     | No                       | 86  | 11.2%   | 17  | 7.4%    |
| If yes, frequency                   | > 1 time / week          | 419 | 61.6%   | 115 | 54.0%   |
|                                     | 1 time / week            | 172 | 25.3%   | 59  | 27.7%   |
|                                     | 1 time / month           | 33  | 4.9%    | 8   | 3.8%    |
|                                     | Irregularly              | 56  | 8.2%    | 31  | 14.6%   |
| Have plants at home                 | Yes                      | 329 | 43.0%   | 97  | 42.2%   |
|                                     | No                       | 436 | 57.0%   | 133 | 57.8%   |
| Vehicles cross besides home         | Most times               | 97  | 12.7%   | 25  | 10.9%   |
|                                     | Sometimes                | 269 | 35.2%   | 66  | 28.7%   |
|                                     | Rarely                   | 399 | 52.2%   | 139 | 60.4%   |
| Do you live near an industrial area | Yes                      | 80  | 10.5%   | 16  | 7.0%    |
|                                     | No                       | 685 | 89.5%   | 214 | 93.0%   |
| Oven used for cooking               | Gas oven                 | 309 | 40.4%   | 69  | 30.0%   |
|                                     | Electrical oven          | 78  | 10.2%   | 74  | 32.2%   |
|                                     | Both                     | 378 | 49.4%   | 87  | 37.8%   |
| House floor nature                  | Covered                  | 228 | 29.8%   | 38  | 16.5%   |
|                                     | Uncovered                | 480 | 62.7%   | 151 | 65.7%   |
|                                     | Both                     | 58  | 7.6%    | 41  | 17.8%   |
| Air conditions                      | Water-based conditioning | 31  | 4.0%    | 12  | 5.2%    |
|                                     | Freon conditioning       | 712 | 93.0%   | 211 | 91.7%   |
|                                     | Fans                     | 78  | 10.2%   | 25  | 10.9%   |
| Use insecticides in the home?       | Yes                      | 372 | 48.6%   | 94  | 40.9%   |
|                                     | No                       | 393 | 51.4%   | 136 | 59.1%   |

P: Pearson  $\chi^2$  test

\* $P < 0.05$  (significant)

Regarding characteristics and related factors of the asthmatic children, 480 (62.7%) were males with their ages ranging from a few months to 15 years with a mean age of  $10.6 \pm 4.9$  years old. Regarding child order, those with asthmas were the first for 229 (29.9%) children, 2nd to 3rd for 270 (35.2%) children, and 4th or later for 267 (34.9%) children (Table 4). Figure 1 illustrates the child-related factors for asthma development among asthmatic children. Exactly, 75.8% the study asthmatic children had been breast fed, 54.1% used antibiotics when they were less than a year old, 52.5% suffered from a wheezing chest before the age of three, 48.8% suffered from frequent respiratory infections, 45.9% used pain killers when they were less than a year old, and 31.2% had been diagnosed with atopic dermatitis. Only 12.3% of the asthmatic children have fever, and 8.1% were diabetic.

**Table 4** Personal data of the asthmatic children

| Personal data            | No  | %     |
|--------------------------|-----|-------|
| Gender                   |     |       |
| Male                     | 480 | 62.7% |
| Female                   | 285 | 37.3% |
| Age of the child (years) |     |       |
| ≤ 2                      | 32  | 4.2%  |
| 3–5                      | 91  | 11.9% |
| 6–10                     | 281 | 36.7% |
| 11–15                    | 362 | 47.3% |
| Child order              |     |       |
| 1st child                | 229 | 29.9% |
| 2–3                      | 270 | 35.2% |
| 4+                       | 267 | 34.9% |

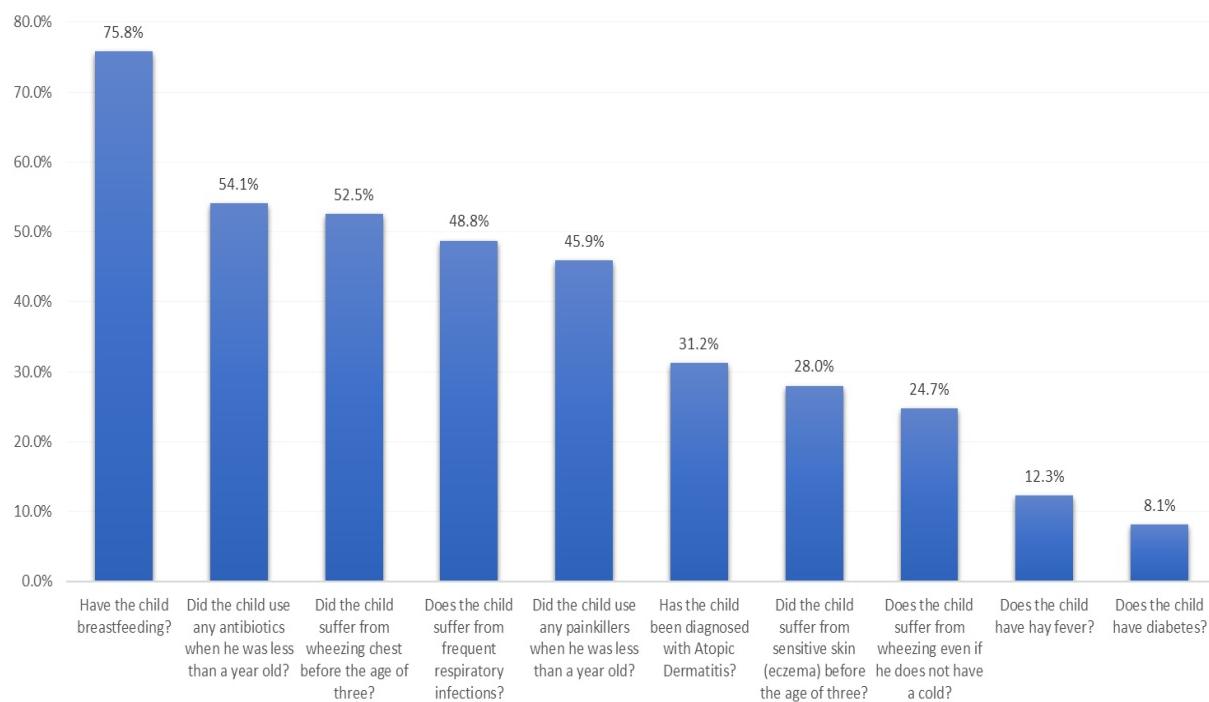
**Figure 1** Child-related factor for asthma development among asthmatic children

Table 5 shows a multiple stepwise logistic regression model for risk factors for asthma. Among all the studied risk factors, the shown factors in the table were the most significant predictors for having asthma among the children. The highest risk factor was having a family history of asthma ( $OR=3.78$ ; 95% CI: 2.68–5.33), followed by rural residence ( $OR=2.80$ ; 95% CI: 1.58–4.97) and a family history of allergies ( $OR=2.41$ ; 95% CI: 1.65–3.53). The lowest risk factor was parental smoking ( $OR=1.53$ ; 95% CI: 1.06–2.22).

**Table 5** Multiple stepwise logistic regression model for risk factors for asthma

| Risk factors                        | p-value | OR <sup>A</sup> | 95% CI |       |
|-------------------------------------|---------|-----------------|--------|-------|
|                                     |         |                 | Lower  | Upper |
| Rural residence                     | .001*   | 2.80            | 1.58   | 4.97  |
| Family history of asthma            | .001*   | 3.78            | 2.68   | 5.33  |
| Family history of allergic rhinitis | .001*   | 1.95            | 1.34   | 2.85  |
| Family history of allergy           | .001*   | 2.41            | 1.65   | 3.53  |

|                               |       |      |      |      |
|-------------------------------|-------|------|------|------|
| Parental smoking              | .023* | 1.53 | 1.06 | 2.22 |
| Lives near an industrial area | .049* | 1.90 | 1.00 | 3.59 |
| Use of a gas oven at home     | .001* | 2.14 | 2.95 | 6.78 |

OR<sub>A</sub>: Adjusted odds ratio

CI: Confidence interval

\*P < 0.05 (significant)

#### 4. DISCUSSION

The current study was conducted to assess and determine the risk factors for developing asthma among Saudi children. We aimed to study the characteristics and asthma-related factors among an asthmatic group, and we concluded that family history of asthma, rural residence, family history of allergic disorders, and use of a gas oven for cooking, besides parental smoking and living near industrial areas, were the most significant risk factors. The incidence of asthma is increasing globally, particularly among children. The Global Asthma Network in 2014 stated that the number of asthmatic people all over the world included 334 million patients (Ellwood et al., 2017; Initiative et al., 1996). In Yemen in 2010, a study was conducted among children aged 13–14 years and revealed that the prevalence of asthma was 14.4% (Bahaj et al., 2012). Another study conducted in Egypt in 2016 among children aged 6–12 years estimated the prevalence of asthma to be approximately 6% (Ahmed et al., 2016). In Saudi Arabia, Alahmadi et al., (2019) assessed that in Saudi Arabia, the frequency of pediatric asthma varies considerably across the nation. Alhofuf had the highest prevalence (33.7 percent), while Abha had the lowest (9 percent). Identification of risk factors of allergic disorders, including asthma and methods of sensitization concluded from different studies, is a necessity for continuous efforts for prevention of these disorders and reducing its burden. All levels of prevention depend on the early detection of clinical signs preceding allergic disorders (Holt & Sly, 1997; Patrick G. Holt & Sly, 2007).

The current study studied many risk factors that may play a role in developing or at least sensitizing for asthma among children. These risk factors included family-related factors, environmental factors and child-related factors. There was a strong relationship between child rural residency and univariate analyses, low level of education of parents, and low income and having an asthmatic child. Regarding family-related risk factors, family history of asthma, family history of allergies, family history of allergic rhinitis, and parental smoking were significantly higher among families with asthmatic children than among others. Considering environmental factors, the families with asthmatic children had significantly more reports of covered house floors, which may have been sensitizers and triggers for asthma. Additionally, more reports of using insecticides were documented in addition to using gas ovens instead of electric ovens, which provide a more clean home environment.

In summary, our logistical model identified a family history of asthma, rural residence, family history of allergic disorders, and using a gas oven for cooking in addition to parental smoking and living near industrial areas as the most significant predictors of childhood asthma. These findings were in agreement with what was reported by Xu et al., (2016) in which a family history of asthma, personal history of allergies (atopic dermatitis, drug allergy, and food allergy), and comorbidities (allergic rhinitis, sinusitis, adenoidal hypertrophy, and urticaria), were discovered to be significantly higher among asthma children than among non-asthma children. Additionally, other researchers in the literature confirmed these relations between the estimated risk factors and asthma among children (Ibiapina et al., 2010; Irani, 2014; Sánchez et al., 2014; Tan & Corren, 2011; Zheng, 2014). Typically, asthma and allergic rhinitis have been frequently reported in the same subjects (Bousquet et al., 2012). More risk factors were reported in Saudi Arabia by Alqahtani et al., (2016) who found that male gender, fast food consumption, trucks passing near houses, and having a dog or cat at home were significant risk factors in contrast to the current study findings. Other studies in Saudi Arabia revealed that house dust mites are the main indoor allergen in different regions with sensitization rates of 26% to 87% (Hassan et al., 2013; Koshak, 2006).

Regarding socio-demographic risk factors for asthma, similar findings as those of the current study have been estimated. Mitchell et al., (1989) in New Zealand estimated a higher rate of wheezing in children in families of low socioeconomic status. On the other hand, researchers in Italy conducted a study on respiratory disorders in childhood, and the environment group showed that urbanization and socioeconomical status had a small effect on the magnitude of wheezing or asthma but could impact the management of asthma (Renzoni, 1997). The severity of asthma prevalence in kids associated with low socioeconomical class in a German study (Mielck et al., 1996), which confirmed the present findings of a higher risk of hospitalization for asthma in the group with psychosocial problems, thereby indicating poorer control of asthma.

## 5. CONCLUSION

Rural residence, low parental education, and lower monthly income were the most significant socioeconomic risk factors for asthma. Family history of asthma, allergies, and allergic rhinitis were the most significant familial risk factors. Presence of a smoking family member was more significant for the development of asthma. Using a gas oven and house floor coverings were more associated with asthma. Additionally, frequent use of incense was significant in the asthmatic group.

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### Ethical consideration

Ethical approval was obtained from Research Ethics Committee at Taif University with the IRB approval number (42-0057).

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This study has not received any external funding.

### Conflict of Interest

The authors declare that there are no conflicts of interests.

### Data and materials availability

All data associated with this study are presented in the paper.

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